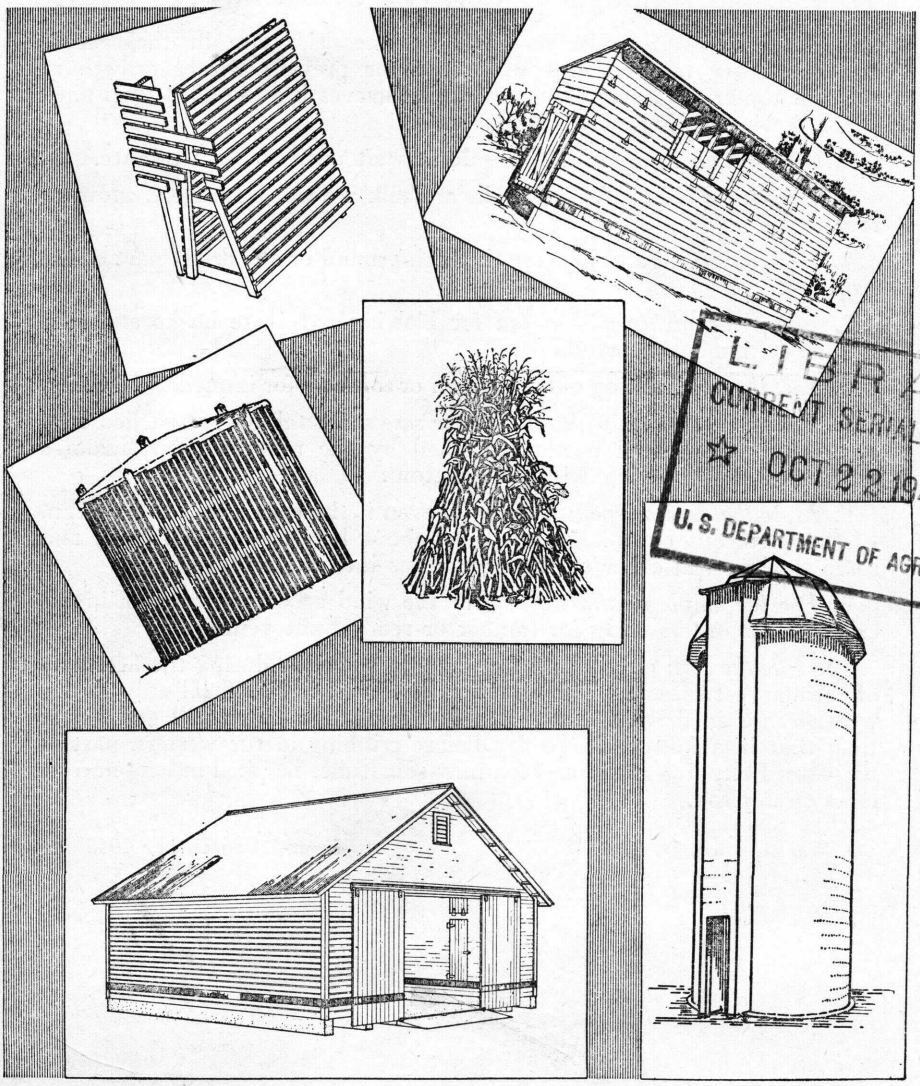
Handling and Storing SOFT CORN on the Farm



Farmers' Bulletin No. 1976
U. S. DEPARTMENT OF AGRICULTURE

To Reduce Damage to Corn in Crib Storage—

1. *Delay harvesting*—the corn will become drier late in the season, and the lower temperatures will retard or prevent winter growth of mold in the crib. Some farmers delayed harvesting the 1944 crop until the following spring with good results.

2. *Get the crib in order at once*—don't wait until the last minute.

3. *Stay out of the field* when husks and silk are wet from frost, snow, or rain.

4. *Divide the field* and harvest the high ground or the driest part of the crop first.

5. *Equip the picker with a fan* for blowing out loose husks and silk, if this equipment is available.

6. *Sort the corn*, taking out the green or soft ears for immediate feeding.

7. *Equip the elevator with an effective screen* for taking out shelled corn and dirt. If a screen is not furnished by the manufacturer, make a section of the spouting with rod bottom.

8. *Move the elevator spout frequently*, even if the corn seems to be clean. Elevator screens often take out only about half the shelled corn, and some shelling will occur as the corn drops into the crib.

9. *Provide ample ventilators* to give the wind access to the corn in the crib. Place orders early for lumber or ready-built ventilators.

10. *Pile the corn* only 2 to 3 feet deep in the cribs during the first part of the harvest season. This practice, however, is beneficial only in dry weather, for in driving rains, corn in the shallow layer will get wetter than that in a full crib. To dry before cribbing in the western part of the Corn Belt, high-moisture corn may sometimes be piled in long narrow ricks on dry sod.

Washington, D. C. **Issued September 1945**

HANDLING AND STORING SOFT CORN ON THE FARM

By C. K. SHEDD, *agricultural engineer, Division of Farm Buildings and Rural Housing, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration* [1]

Contents

SOFT CORN may be a serious problem in the Corn Belt in any year when a late spring delays planting or when wet, cool weather during the growing season prevents proper maturing and drying of the crop. The trouble is likely to be worse after a series of years with longer than normal growing seasons during which farmers become accustomed to growing varieties or hybrids of later maturity than can ripen in a normal season. Planting early maturing seed is excellent insurance against soft corn.

Soft corn may range from ears that are substantially mature, but still excessively wet, to corn that is immature and watery. In either case the excess water in kernels and cob is the principal cause of loss in storage.

Soft or high-moisture corn is generally a result of late maturing. In the central part of the Corn Belt, for example, corn should be mature (that is, at the point where growth stops) by about September 15 to 20 if the necessary additional drying is to take place in the field before time to harvest. When corn does not reach maturity until October, the cooler weather slows the drying rate and the time left is usually not sufficient for proper drying in the field. Regardless of the cause of the high moisture content, some spoilage is to be expected if ear corn is cribbed in the ordinary way and if the kernels contain more than 20 percent moisture. The higher the moisture content the greater the difficulty of storage.

[1] This bulletin is based in part on investigations conducted in cooperation with the Iowa Agricultural Experiment Station; acknowledgment also is made to E. A. Ellison, of the Commodity Credit Corporation; to H. D. Hughes, of the Iowa Experiment Station; and to others who assisted in its preparation.

DRYING RATE OF CORN ON STALK

The kernels on an ear in the early stages of development contain as much as 85 percent water. The other 15 percent is starch and other materials that later will be solid and will be called dry matter. As the kernels mature gradually they become harder and drier. At harvesttime, under favorable conditions, they may contain 20 percent or less of water and 80 percent or more of dry matter.

The rate at which normal corn matures and dries on the stalk has been determined by taking samples of ears at weekly intervals from the same field and noting the moisture content of kernels and cobs. The study was made at Ames, Iowa, in September and October 1940, when weather conditions were more favorable than usual for drying corn in the field. The kernels contained 58 percent moisture and the cobs 64 percent on August 28, when about half the kernels were dented. On September 20, when the plants were mature, the kernels contained 34 percent moisture and the cobs 55; and on October 30 the kernels contained 16 percent and the cobs 23. The corn was then about as dry as at any time in winter.

The results of the 1940 study are compared with conditions in 1944–45 in figure 1, which shows also the moisture condition that may

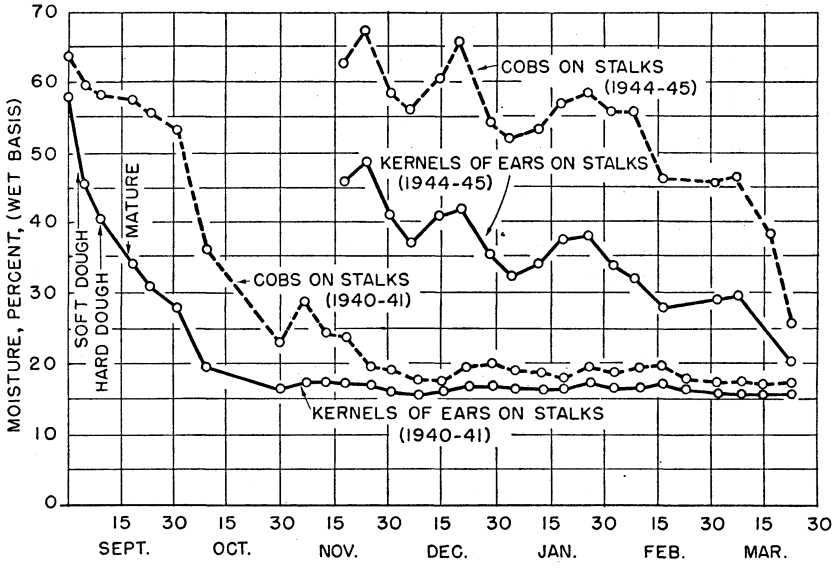


FIGURE 1.—Moisture content of kernels and cobs on standing stalks, fall and winter of 1940–41 and 1944–45.

occur and result in storage difficulty. In 1944 the kernel moisture content of corn from a single field near Ames still was 46 percent on November 17 and remained above 30 percent until the middle of February. This field was more or less typical of a part of the 1944 crop that was planted late and did not mature and dry as in a normal season. For this kind of crop special attention must be given to methods of storing.

TESTING MOISTURE CONTENT

The best way to determine the condition of the corn is to test the moisture content of field samples. In many parts of the Corn Belt local grain elevators and county offices of the Agricultural Adjustment Agency are equipped for testing the percentage of moisture in shelled corn. Since some ears will be more mature than others, the results of tests may be misleading unless care is taken to get representative samples, at least 2 of which should be taken from the same field. To obtain 1 sample, at least 20 ears should be picked at random in the field, and with a screw driver 2 rows of kernels should be shelled from each. The shelled corn should be sealed up at once in a pint fruit jar, which should be full or nearly full.

HANDLING SOFT CORN [2]

FEEDING

Immature corn has about the same feeding value per pound of dry matter as mature corn, and as long as it remains sound it can be fed safely to all kinds of stock. This feeding should be begun carefully, however, the quantity being increased gradually to full feed. Caution needs to be exercised in feeding soft corn to poultry. Moldy corn should not be fed to horses and sheep, especially lambs; they are susceptible to injury from such feed. It can safely be fed to cattle, as seemingly they are not so subject to this danger, and also to hogs as long as they will eat it. Prompt feeding unquestionably is the best disposition to make of immature corn, so far as this is practicable. As in feeding sound corn or other grains, protein and mineral supplements should be provided.

Hogging down soft corn is a safe and satisfactory practice, but the hogs must be accustomed to it very gradually. Only a little should be fed at first and the quantity increased gradually to full feed, when the hogs may be turned into the field. Since there is a tendency for greater wastage of feed in hogging down soft corn, it is a good practice to make the hogs clean up successive strips of the cornfield by the use of temporary fences.

ENSILING

Ensiling is one of the best means of saving soft corn. If there is not enough capacity in permanent silos, temporary silos may be used. Trench, snow-fence, and stack silos are described in Farmers' Bulletin 1820, Silo Types and Construction, and in numerous publications of the State agricultural colleges.

The whole corn plant can be safely made into silage while immature or very immature. Although such silage is not so valuable as that from more mature corn, because of its high water content and lower feeding value, it makes a satisfactory feed for cattle, and this is one of the best uses for it. Good silage can also be made from corn that has been frozen; after it has been frozen, however, it should be put into the silo as promptly as possible.

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[2] Much of the material in this section was obtained from the following publication: RICHEY, F. D. HANDLING THE SOFT-CORN CROP. U. S. Dept. Agr. Dept. Cir. 333, 8 pp., illus. 1924.

EAR-CORN SILAGE

In many instances, ensiling may be a practical method of saving ear corn that is too soft for safe storage in cribs. In making snapped or husked ear corn into silage the same principles apply as in making whole-plant silage. The ears may be chopped in an ensilage cutter. The chopped material must be packed sufficiently to exclude air. Usually it will be necessary to add water, the quantity depending upon the condition of the corn, but there should be enough to bring the moisture content up to at least 50 percent, and preferably to 60 percent. If the ears have dried down to 40 percent moisture, it will be necessary to add 1,000 pounds of water to each ton of ears to bring the moisture content up to 60 percent.

If possible, a small-diameter silo should be used for ear-corn silage since it is a more concentrated feed than whole-plant silage. The quantity fed per animal per day will be smaller, and a larger number of animals should be fed from a silo of given diameter to avoid surface spoilage of corn in the silo. Also, ear-corn silage is heavier than whole-plant silage, and extra steel reinforcing may be needed if the silo is filled full.

CUTTING AND SHOCKING

Shocking may save a part of a poorly matured crop. Under ordinary conditions in the Corn Belt nearly mature corn can stay in small shocks safely until the ears are dry enough to crib, even if this takes all winter; in fact, the ears will be safer in small well-made shocks than in the crib. If the corn is very immature there is danger of molding in large shocks, but if properly cured, such fodder has about the same feeding value as timothy hay.

CRIBBING

Except under very humid weather conditions, ears of corn, even if very high in moisture content, can be stored without molding by hanging them up in a shelter where they will be fully exposed to the wind. In a crib, however, air movement around the ears is greatly restricted, and for safe storage in ordinary cribs the moisture content of the kernels should be down to 20 percent when the corn is cribbed. In a large part of the Corn Belt, corn cribbed with 20 percent moisture usually does not dry below 15 to 17 percent moisture in winter, but further drying takes place after the weather warms up in spring. Under normal conditions it will be dried down by early summer to 13½ percent moisture, which is about the upper limit for safe storage as shelled corn in tight bins.

IMPORTANCE OF CLEAN HUSKING

Cleanness of husking is of the utmost importance in storing corn of high moisture content, because the presence of husks and silk seriously retards air movement through the crib. Even when corn matures normally, it will be safe to start harvesting several days earlier with a machine that husks clean than with one that leaves much husk and silk with the ears. In an experiment at Ames in 1943 a crib 8 feet wide was used for storing corn containing 29.6 percent moisture. When it was emptied the following April, 21 percent of the kernels were damaged in that part of the crib where 9 percent (by weight) shelled corn and 4 percent husks and other debris were mixed with

the ears. At a similar location where 3.6 percent shelled corn and 0.7 percent debris were mixed with the ears, the kernel damage was only half as great.

Other tests showed that with the same air pressure and the same thickness of corn, nearly three times as much air passed through clean ear corn as through ear corn with 3.7 percent shelled corn and 1.7 percent debris uniformly distributed throughout the mass. Such quantities of shelled corn and husks are not at all unusual when a mechanical picker is used. Shelled corn, chaff, dirt, or other materials that tend to fill the space between ears in storage retard aeration and should be removed before the corn is cribbed.

Portable elevators are now generally equipped with screens that take out the shelled corn, chaff, and dirt. Vertical elevators without such screens are used in many double-crib buildings. If a shelled-corn remover is not supplied by the manufacturer of the elevator, a simple home-made separator can be made by building a section of the spouting with rod bottom (fig. 2). The ears pass over the rods, but

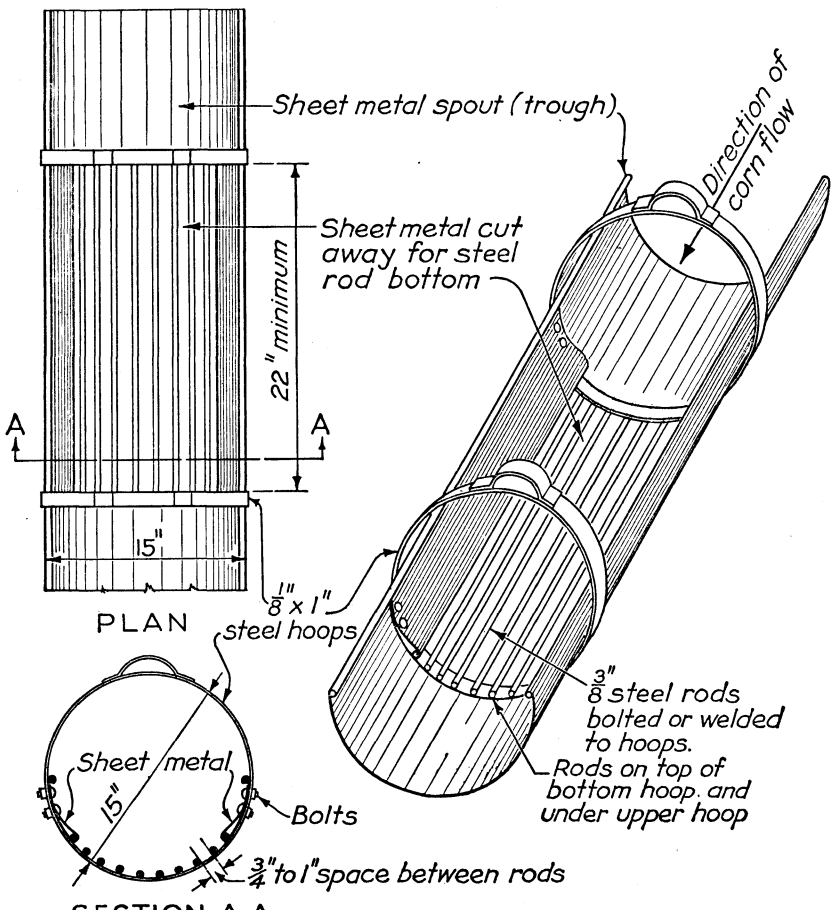

FIGURE 2.—Section of spouting of grain chute equipped with rod-bottom separator, by use of which the ear corn passes into the crib and the shelled corn, chaff, and dirt is removed.

the shelled corn drops through. The debris removed by such a screen is likely to be too damp to be stored in quantity. Usually it can be fed to livestock immediately or else spread out in layers thin enough to prevent heating.

NORMAL CRIB REQUIREMENTS

1. The crib should be no wider than the maximum that is recommended for the area where the corn is stored (fig. 3).

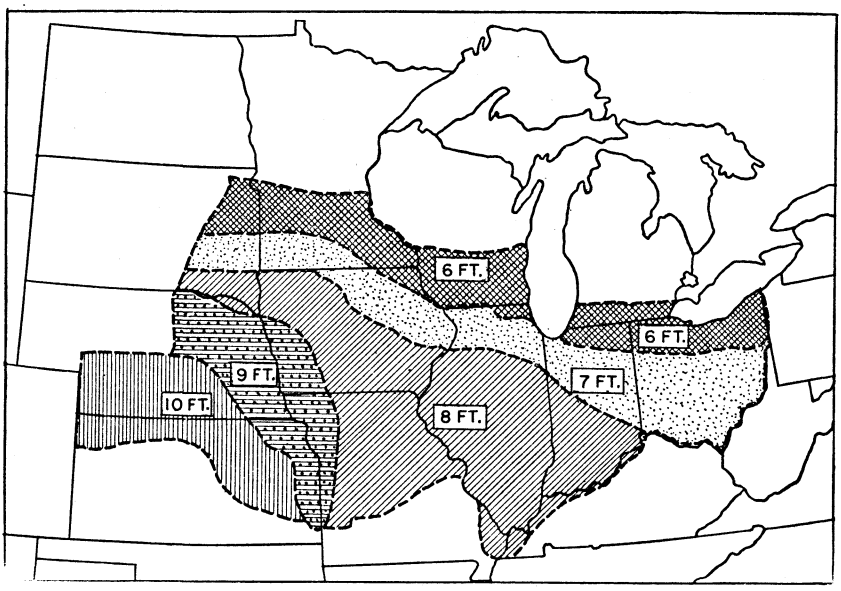

FIGURE 3.—Maximum crib widths recommended for the commercial corn area.

2. A floor and good drainage are necessary to protect the corn from ground moisture.

3. A tight roof is essential in humid areas and also in the western part of the Corn Belt, if the corn is to be stored through the summer.

4. The crib should not be sheltered from the wind by trees or by other buildings. It is wind pressure that causes air movement through the crib.

INCREASING AIR MOVEMENT THROUGH CRIBS

WIDTH AND EXPOSURE OF CRIBS

The width of the crib is the most important dimension affecting air circulation. A wide crib filled with corn offers more resistance to air movement than a narrow one. Tests show that in a 10-foot crib the air movement per bushel of corn is only about two-thirds that through an 8-foot crib. Filling the driveway of a double crib makes the building into a single crib the entire over-all width of the building. This should be done only when the corn contains less than 20 percent moisture and then only through the cold winter months, unless the moisture content is down to 12 or 14 percent.

CRIB VENTILATORS

In soft-corn-crop emergencies various types of removable ventilators have been used to increase the air movement through the corn in cribs. Four types of ventilators (*A*, *B*, *C*, and *D*) are shown in figures 4 and 5.

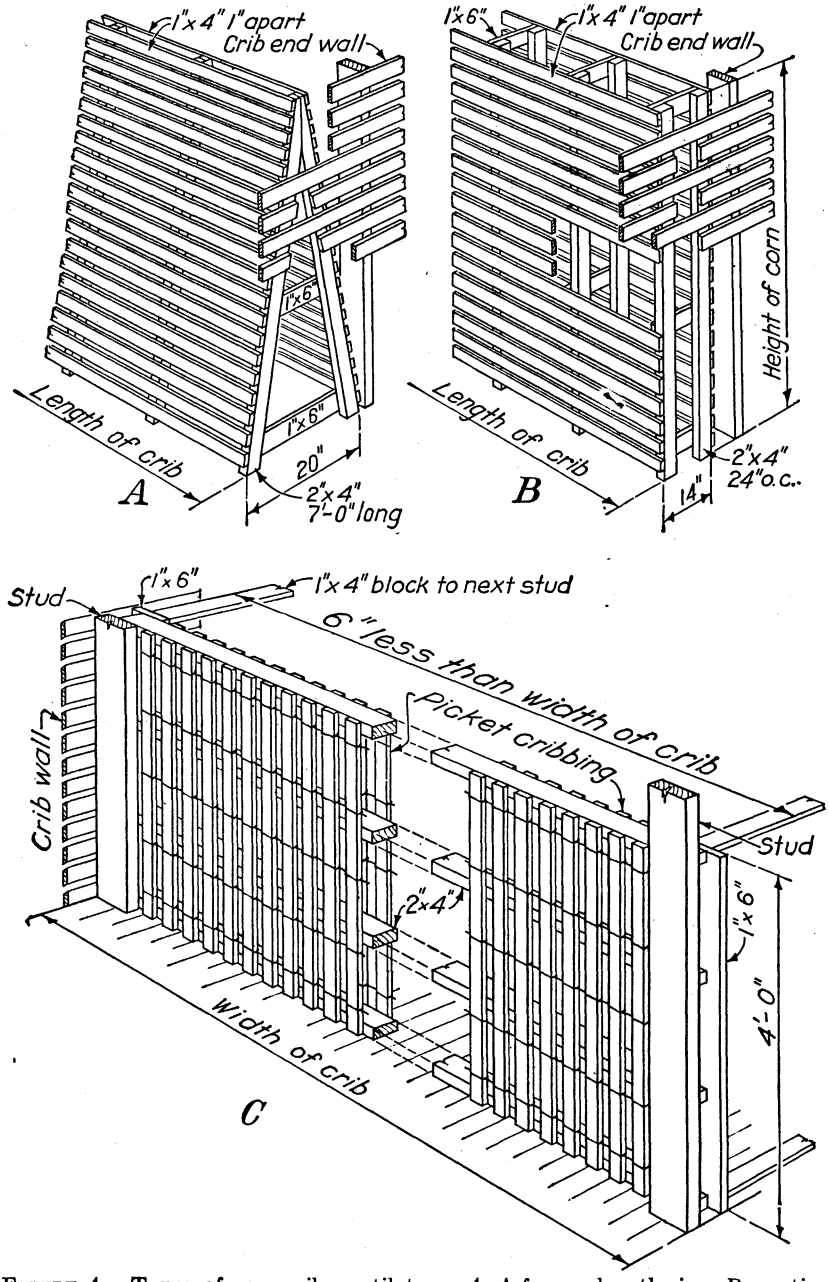

FIGURE 4.—Types of corn-crib ventilators: *A*, A-frame, lengthwise; *B*, vertical sides, lengthwise; *C*, double vertical slats, crosswise.

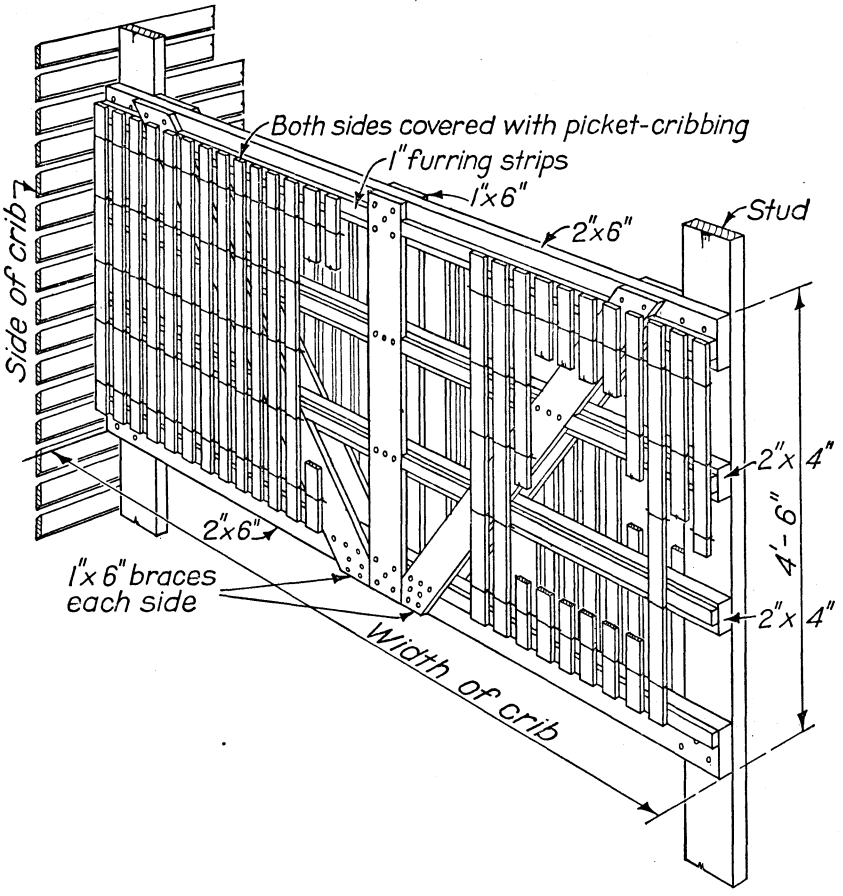

FIGURE 5.—Combination ventilator and cross brace, type *D*, crosswise.

Ventilator *A* (fig. 4), the A-frame ventilator, should run through the center of the crib from end to end to allow the passage of wind. It may be best to block the ventilator midway in its length, but these ventilators have proved successful both with and without blocking. Filling above the top of the ventilator should be delayed until the latter part of the harvest season, when the corn will be drier and the temperatures lower. This ventilator sets below and clear of the cross ties in the crib and can be built in sections that are short and not difficult to handle. It causes some inconvenience in emptying the crib.

Ventilator *B* (fig. 4), with vertical sides, runs from end to end of the crib, full height of the corn, so that wind can blow through the center. It is the most effective, but the objections are that (1) considerable lumber is required to build it; (2) the cross ties interfere with installation; (3) if built in sections between the cross ties the sections are heavy and awkward to handle; and (4) in emptying the crib a central shelling trench cannot be used—both sides of the crib must be opened.

Ventilator *C* (fig. 4), with vertical slats, is lighter in weight and cheaper than either the *A* or *B* types. It is built in sections the height of the picket cribbing (snow fencing)—4 feet. These sections can be set one above another to the height of the corn. It is best adapted to placing crosswise in the crib from wall to wall and can be braced between the studs and spaced as close as required according to the condition of the corn. Cross bracing of the crib does not interfere with an installation of this type, and the ventilators do not cause much inconvenience in emptying the crib.

Ventilator *D* (fig. 5) is a combined ventilator and cross brace and is a permanent installation. It should be located 6 feet 6 inches above the floor to allow headroom for men working on the floor when emptying the crib. The ventilator height of 4 feet, as shown, is sufficient for a crib 12 feet high. For a crib 16 feet high, another 4-foot ventilator can be added above. These ventilators should be spaced 4 feet apart, the same as the usual spacing of cross braces, and firmly attached to the studs. Two ½-inch bolts or five twenty-penny spikes are needed at each end of the lower 2 by 6 timbers. The cost of this combined ventilator and cross-brace type will be more than that of the usual cross brace, but not so much as a cross brace plus a removable ventilator. Removable ventilators should be placed below these permanent ventilators if corn of more than 25 percent moisture is to be stored.

Among other kinds of ventilating devices are strings of drain tile or poles set slanting in the crib to keep air channels open as the corn settles. The principal considerations are to use the cheapest or most readily available materials, to provide for air movement under wind pressure through the ventilator, and to install a sufficient number of ventilators, depending on how wet the corn is. Usually there should be not more than 4 feet of corn between the ventilators illustrated in figures 4 and 5 or between ventilator and crib wall. If drain tiles or poles are used, the spacing should be close enough to give equal air movement.

Bill of Materials for Ventilators

Type A.—Section 6 feet long, 6½ feet high:
Lumber: Four pieces 2 by 4 inches by 14 feet; thirty-four 1 by 4 inches by 6 feet; one 1 by 6 inches by 10 feet.
Nails: 1¾ pounds sixpenny, ½ pound eightpenny, ¾ pound twelvepenny.

Type B.—Section 8 feet long, 12 feet high:
Lumber: Ten pieces 2 by 4 inches by 12 feet; three 1 by 6 inches by 10 feet; fifty-eight 1 by 4 inches by 8 feet.
Nails: 3½ pounds sixpenny, 1¼ pounds eightpenny.

Type C.—Section 8 feet long, 4 feet high:
Lumber: Four pieces 2 by 4 inches by 8 feet; one 1 by 6 inches by 8 feet; one 1 by 4 inches by 8 feet; 14 linear feet picket cribbing (snow fencing), 4 feet high.
Nails: ¾ pound fourpenny, ¼ pound sixpenny.

Type D.—Section 8 feet long, 4½ feet high:
Lumber:
Ventilator: Two pieces 2 by 4 inches by 8 feet; eight 1 by 2 inches by 8 feet; 15 linear feet picket cribbing (snow fencing), 4 feet high.
Brace: Two pieces 2 by 6 inches by 8 feet; two 1 by 6 inches by 16 feet.
Nails:
Ventilator: ¾ pound fourpenny, ½ pound sixpenny.
Brace: ½ pound eightpenny, ¾ pound twentypenny. Not less than 5 twentypenny nails at each joint of 2- by 6-inch braces, clinched across grain.

FORCED VENTILATION WITH UNHEATED AIR

The principal difficulty in forced ventilation of corn in a crib, aside from the expense involved, is getting equal air movement through the different parts. If air is driven by a power blower into a ventilator in the center of the crib, the ventilator and its location should be such that the escaping air must pass through as nearly as possible the same thickness of corn in all directions. Any husks or shelled corn mixed with the mass should be uniformly distributed, as air escaping from the ventilator will bypass any spot having excess debris.

Forced ventilation by the method thus explained was tried with an ensilage-cutter blower in 1943 on corn containing 29.6 percent moisture in a 10-foot crib with central ventilator. Husks and shelled corn were not uniformly distributed. The blower was operated 105 hours on mostly clear days from October to December. When the crib was emptied the following April the corn contained 20.4 percent moisture, and 8.5 percent of the kernels were damaged by mold. Similar corn stored until April in a 6-foot crib without forced ventilation had 18.1 percent moisture and 9.2 percent damaged kernels.

To dry corn successfully in a crib by forced ventilation with unheated air, it is necessary to operate the blower frequently enough to prevent heat and mold damage until the weather is cold and thereafter for a long period in spring when the weather is warming up. Uniformly clean corn and proper design and location of the ventilator are necessary for uniform distribution of air flow. Unless these requirements can be met, forced ventilation with unheated air cannot be generally recommended.

TEMPORARY CRIBS

When permanent cribs do not have sufficient capacity for the entire crop, temporary cribs should be built for the rest of it. The most common type is that made with woven or welded wire cribbing or with picket cribbing (snow fencing) set in a circle, but in an emergency woven fence wire can be used. The usual diameter of a circular crib is about 16 feet; it is most frequently made with a 50-foot length of fencing. If the corn has a high moisture content the crib diameter should be reduced to 12 feet or even less, especially in the more humid parts of the Corn Belt. A circular crib is not the best type for moist corn, because the diameter is usually greater than the recommended width of a rectangular crib and, when it is filled by elevator, the debris of shelled corn, husks, and silk accumulates in the center, which is the worst possible position for it.

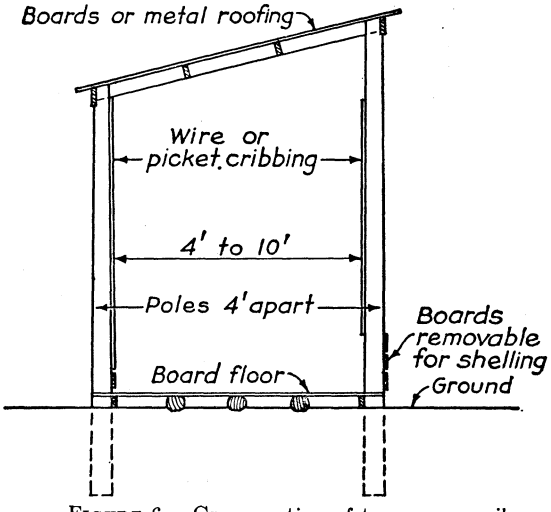

FIGURE 6.—Cross section of temporary crib.

A better type of temporary crib for soft corn is made in rectangular shape by using poles set about 4 feet apart to support wire or picket cribbing for the walls, which are 4 to 10 feet apart, as shown in figure 6. The corn will be better aerated than in a circular crib of ordinary diameter, and the roof is more easily built.

Usually the most practical floor for a temporary crib is made of boards laid on timbers or split logs that will support them about 6 inches above the ground. A shelling trench through the center of a circular crib will save labor when the corn is shelled out; it also provides some of the ventilation needed for moist corn.

If corn is piled on the ground when harvested and is not fed during the winter, it should be moved into cribs before spring. It is hazardous to crib corn when it is mixed with snow and ice or when it is wet from rain. It had better stay in the pile until the corn on the surface is dry.

CRIBBING SOFT CORN

MOISTURE CONTENT OF 20 TO 25 PERCENT

Corn containing 20 to 25 percent moisture in the kernels may be severely damaged if harvested and cribbed without special precautions. Harvesting should be delayed until cool weather (the latter part of October or early November in the central part of the Corn Belt). Clean husking is important. Shelled corn should be screened out as the corn goes into the crib. Green or soft ears should be sorted out. Crib ventilators will be beneficial and their use is recommended, especially if the moisture content is near 25 percent or if the crib width exceeds the maximum recommended for the locality. (See fig. 3.)

MOISTURE CONTENT OF 25 TO 30 PERCENT

Corn containing 25 to 30 percent moisture in the kernels is very likely to spoil in cribs. It should be allowed to dry in the field as long as the weather is favorable and should not be harvested until the weather is cold. Then every precaution should be taken to remove husks, silk, and shelled corn, and the corn should be sorted to remove the softest ears. Crib ventilators should be used with spacing not more than half the width of the crib between ventilators or between ventilator and crib wall. If these conditions are provided, with normal drying weather in spring the corn may dry out and store through the following summer without severe damage, but it should be watched closely for any signs of heat or mold damage as the weather warms up in spring. If heating or molding starts at this time, it may be best to feed the corn promptly, to ensile it, or to sell it if possible. If it is necessary to hold it in crib storage—

1. Move the corn as soon as possible. Loosening what has settled through the winter permits better air circulation in spring, when drying can occur.

2. As the corn is moved, sort out loose husks and silk, shelled corn, and chaff. Any debris that partially fills the spaces between the ears is detrimental to air movement. A good deal of the shelled corn and chaff can be sorted out by scooping with a cob scoop rather than with a grain scoop. Elevators can also be so made as to screen out some of these materials. If possible, an air blast should be used to blow out husks and silk.

3. Sort out any soft or moldy ears.
4. Then place the corn in a well-ventilated crib.

MOISTURE CONTENT ABOVE 30 PERCENT

Corn containing more than 30 percent moisture in the kernels is likely to spoil in the crib if held longer than through the cold winter months. If possible it would be better to handle it by methods other than cribbing. There may be heat and mold damage in the crib even in winter, unless good aeration is provided by the methods suggested for corn of lower moisture content. If corn of more than 30 percent moisture must be kept in storage after cold weather ends, the possibility of drying with heated air may be investigated. Forced ventilation is another possibility. Otherwise, a good deal of moving and spreading in thin layers may be necessary to prevent spoilage by heating and the growth of molds.

DRYING WITH HEATED AIR

If a seed-corn drier is available within trucking distance, artificial drying of soft corn before cribbing may be practical. This process involves extra handling of the corn (into and out of the drier) and the operating expense for fuel and power, but the cost of providing ventilators in the crib is eliminated. At the present stage of development of artificial drying plants the first cost is an obstacle to construction for drying corn for feed or market under Corn Belt conditions.

If the dried corn is to be sold for any use except livestock feed, care should be taken not to overheat it. Air temperatures higher than about 110° F. apparently cause undesirable changes.

In some cases soft corn has been dried successfully by blowing heated air into a ventilator in the center of the crib. If a furnace is available for temporary use and an ensilage cutter or a threshing-machine wind stacker for blowing the air, the equipment can be set up without a great deal of expense. It is necessary to provide the same conditions to get uniform distribution of air flow as explained for forced ventilation with unheated air. (See p. 10.) The path of the air between the points of entering and leaving the corn should be as short as possible, preferably not more than 4 feet, for if the path is too long, water evaporated by warm air near the inlet may be redeposited in another part. Under good conditions, drying a crib of corn may be accomplished in less than a week of operation.

SALTING SOFT CORN

Experiments in the use of salt to preserve soft corn were carried on in 1917 by H. D. Hughes,[3] of the Iowa Agricultural Experiment Station. Information also was obtained from a number of farmers who had salted soft corn in cribs. It was found that ½ to 1 pound of salt per 100 pounds of corn (35 to 70 pounds of salt for each 100 bushels) was beneficial in reducing fermentation and mold growth. Under severe conditions, however, the use of salt did not prevent spoilage. It was thought also that any larger proportion of salt would cause difficulties in feeding the corn. Salting is not a substitute for other measures. Good aeration to dry the corn is still necessary.

[3] HUGHES, H. D. SALTING SOFT CORN. Iowa Agr. Expt. Sta. Cir. 41, 7 pp. 1917.

POINTS TO REMEMBER

Soft corn is a valuable feed—don't let it spoil.

Fall and winter feeding and ensiling are the surest ways to save soft corn.

Cutting and shocking in small shocks is sometimes advisable.

Do not be in a hurry about picking soft corn—it dries faster on the stalk than in the crib.

Before picking the corn, test its moisture content. (Take precautions described on p. 3.).

When cribbing soft corn, delay harvesting until cold weather, husk clean, and *provide plenty of crib ventilation.*

U. S. GOVERNMENT PRINTING OFFICE: 1945

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